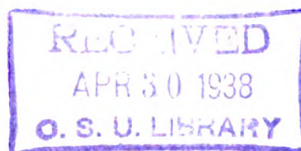


UNITED STATES
DEPARTMENT OF THE INTERIOR
HAROLD L. ICKES, SECRETARY

BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

THE BUREAU OF MINES AND MINERAL UTILIZATION



BY

JOHN W. FINCH

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

THE BUREAU OF MINES AND MINERAL UTILIZATION^{1/}

By John W. Finch^{2/}

The present epoch in human history has been variously described as the age of coal, of oil, of iron and steel, and of power. All agree, however, that it is a great industrial period.

Power is of course the vital force in the industrial organism; but power is derived chiefly from mineral fuels or from harnessed and controlled water - also a mineral substance although usually not so classified by industry. However, the latent energy of fuels cannot work for men until it is changed to active energy by combustion and until this active energy is converted into motion. This motion is just as indispensable as the energy itself. Likewise, the latent energy of water cannot be utilized until it, too, is converted into motion; but the mechanisms and devices for converting latent energy into motion, as well as the structures in which they are operated, would not be possible without metals and other minerals. Consequently, minerals are fundamental in industrial civilization.

The mere possession of mineral resources does not of itself create an industrial civilization, as can be seen in many backward countries that are well endowed with minerals. The value of mineral raw materials lies in their effective use, and this country has used them to a superlative degree. For this reason, perhaps the best name for the present period in the United States would be the age of mineral utilization.

The transition from an agricultural to an industrial system in the United States came much later than in European countries, but here mineral utilization has brought a more rapid increase of material and social benefits than in other lands. Even before the beginning of this century the mineral technology of the United States had become preeminent in the world, and in the past 25 years the value of mineral products has increased 77 percent, in step with an expanding industrial life.

It would be no exaggeration to say that the minerals of the country have definitely shaped its destiny. The territory of the United States is so large that its permanent unification under a single government would have

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 6996."

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been difficult if not impossible without railroad, telegraph, and telephone lines that linked together the far-flung areas of the Nation. Metals were the vital requirements in building these lines; fuel was just as necessary to operate the railroads; and all varieties of minerals were essential in the creation of the expanding industries that grew up in their wake.

The contribution of the mining industry to the railroads did not cease with their construction. During a recent year minerals and their derivatives provided 74 percent of railroad freight tonnage and 55 percent of revenue, and this business is increasing rapidly.

The astounding development of mineral oil and the utilization of its products have created a new epoch of swift transportation by automobiles, busses, and trucks, and these have caused the rapid construction of wonderful highway systems which, incidentally, are built of other minerals. All-metal airplanes, mineral-oil-propelled, span the continent in 16 hours in regular commercial service, and this magic speed of travel for mail, merchandise, and passengers has profoundly affected the whole tempo of modern living.

The Nation's yearly output of mineral raw materials apparently sells for only about a third of the total for all raw materials produced in the country. However it should be noted that the production of agricultural materials, for example, depends upon implements supplied by the mineral industries. The farmer would not choose to return to the wooden plow or to winnowing grain in the wind. Moreover, minerals consumed (except fuels) generally are not destroyed as are foods. More than half of the minerals produced enter into lasting facilities: Buildings, metal and concrete bridges, roads, railroads, power-transmission and communication lines, water, sewage, and drainage systems. Much of the balance goes into temporary use in machines, and industrial, farm, and household tools and utensils, but a large part of the metals thus used is not consumed and destroyed. More and more is becoming permanent by returning as scrap to be refabricated, thus continuing in a constantly growing revolving mineral fund.

The accrued value of steel and the chief nonferrous metals that have entered as raw materials into permanent or recurring use since 1800 is more than 70 billion dollars. It appears safe to say that of this total 50 billion dollars worth is still in use. Of the metals lost in use, zinc suffers most, lead next, and iron and copper least.

The stupendous value of mineral raw materials as they come from the earth is only a small fraction of their value as they enter into use. Iron ore sells, say, for about \$2.50 a ton at the mine; 2 tons of ore should yield 1 ton of finished steel selling from \$30 to \$100 per ton for the principle industrial uses, with perhaps an average of about \$50 per ton. Here the raw material is increased about 10 times in value. However, much of the ore is made into extensively used special alloys that sell from \$100 per ton up to many dollars per pound; 1 pound of steel hairsprings used in watches is worth about \$100,000, and here the increment becomes bewildering.

Copper, lead, and zinc also are multiplied in value many times as the primary metal from the smelter passes into use as pipe, sheets, pigments, and other manufactured products.

The fuels also increase in value. Coal at \$2 per ton yields products from coke ovens worth \$16.25. Crude petroleum at \$1 a barrel increases in value more than 20 times as it passes through refineries and the distribution system, as gasoline retails for 15 to 20 cents per gallon and lubricating oil for a dollar or more per gallon.

The nonmetallic minerals likewise take on a large increment when utilized, although they do not generally return for refabrication. Consider a great city like Chicago with its commercial and residential buildings, its streets underlain with thousands of miles of pipes and cables; its thousands of automobiles, trucks, and busses; its fleets of metal, lake-going vessels; its trains and tracks; its great manufacturing establishments; and its household utensils and mechanical equipment. What is the value of the city in fabricated metals and other minerals? Judging from assessment figures it may be as much as 6 billion dollars.

Now lump together in imagination the same property items for the cities and towns of the whole United States and add the vast Army and Navy establishments, government buildings, air-transport facilities, and great commercial vessels of steel plying the seas. Exact figures do not exist, but one can deduct from the total national wealth the public and private property represented by farm land and forests and feel assured that the mineral industry created most of the balance.

For example, the entire wealth of the United States in 1932 was given as 163 billion dollars. Probably it is more than that today. Farm land and buildings in 1930 were valued at approximately 48 billion dollars. Another 15 billion might be deducted for forest property, leaving approximately 100 billion dollars as the amount of our national wealth having its origin in the mineral industry.

Many people think of mining as a reprehensible business in the bowels of the earth, or vaguely as the romantic background of "he-man" western stories, or as something that used to be done and was needed in the days of pioneer struggles. All of these conceptions are false. The tonnage of minerals produced from mines that are open to the light of the sun is far greater than that from mines at depth. The "romantic" days of California in forty-nine and of the Klondike in ninety-eight have passed, and mining today is a business - a big business - conducted on strict commercial lines. Far from mining having gone out of fashion, mineral production in 1936 was valued at 4-1/2 billion dollars; metal-mine returns were much greater than in the previous year; the value of the 1936 output of gold was the largest on record in the country's history - 132 billion dollars; bituminous-coal output was the highest since 1930; metals used in building and in highway construction were produced in much larger quantities; the record-breaking consumption of gasoline - 482 million barrels - reflected the upward swing in general trade conditions; and the production of crude petroleum in 1936 set an all-time record of more than 1 billion barrels.

In fact, mining is something more than a business - it is a major industry. Like all industries it depends greatly upon technology and economics - technology to insure efficiency in production of raw materials, to prevent waste in their treatment or preparation for market, and to devise new or better uses for the finished product; and economic studies to permit adjustment of producing capacity to local and world-wide trends in consumption and utilization.

Health and safety of workers and conservation of resources have always been major considerations of the Bureau of Mines; aside from these, technology and economics are the two main features of the Bureau's work. A few examples of the Bureau's technologic work on production, treatment, and utilization of mineral substances follow.

In studies of fuels the Bureau has determined the amount of gas and coke obtainable from 50 typical American coals and by this work has developed a method for estimating the yield of gas, coke, and byproducts from any other coal, if its chemical analyses is known. It has studied methods of washing coal to remove the impurities in it as it comes from the mine, and this has enabled the producer to supply cleaner and more efficient fuel for power plants and homes. The Bureau gives advice as to efficient use of fuels in Government power and heating plants and has published a handbook for general use on the proper methods of burning fuel, not only to get more effective heat but also to prevent smoke. It has developed a process and is operating a small plant to produce gasoline and other motor fuels from coal by what is called hydrogenation and is studying the byproduct oils and tars obtained in this process from the standpoint of their commercial utilization.

In the field of mining the Bureau has studied methods and costs in most of the mining districts in the country and has published the information as it was gathered, thus making knowledge of the best practices available to all. It is conducting detailed research on special mining problems such as the advantages of different types of steel and steel alloys for rock-drill bits; the noxious gas given off by the explosives used in blasting; means of elimination or control of dust produced in mining; and apparatus and technique for determining the strength and predicting the failure of mine roofs and pillars and for measuring vibrations caused by blasting and their effect upon neighboring buildings.

In its metallurgical work the Bureau investigates the treatment and preparation of mineral raw materials from their condition as mined to the finished product ready for use, starting with theory, working logically through laboratory investigation of new methods, and concluding with plant-scale testing to the point of practical application. This work has resulted, among other things, in the development of a process for producing chemically pure chromium at a cost perhaps as low as 20 cents a pound and in a process for making metallic manganese from low-grade ores that are found in the vicinity of large western hydroelectric power plants. (Chromium and manganese have always been almost wholly imported.) Another achievement in metallurgical research was the devising of an apparatus for applying high-pitched sound waves to the removal of dust and smoke from smelter fumes or factory chimneys.

The effective use of mineral raw materials must be use without waste or needless destruction so that the Nation's resources, insofar as they are not needed for the well-being of the present population, will be preserved for the needs and enjoyment of future generations of Americans. The early history of the petroleum and natural-gas industry in this country is a shameful example of wasteful mineral exploitation. Incident to the development of one Texas field alone, billions of cubic feet of natural gas were lost in the atmosphere, and the old-time practice of letting new wells blow wild undoubtedly advanced the day when the country's oil reserves will be exhausted. Formerly only a small part of the oil and natural gas underground was brought to the surface and used, and although today perhaps half is recovered in best practice it is still the object of modern petroleum engineering to increase the percentage as much as possible. The Bureau has given technical assistance toward the realization of that ambition by work on the following important phases of petroleum technology: Prolonging the producing life of wells through application of better engineering practice; estimating the probable life of wells by working out relations between the rate of production and pressure drop in the producing formations; and avoiding waste in transportation and storage. The Bureau has assisted also in the improvement of petroleum refinery technology, so that more and better products may be obtained from the crude petroleum brought to the surface.

The Bureau has continued research on methods for making America self-sufficient in minerals that have to be imported from abroad, particularly those of importance in warfare. Many known deposits of chromium, manganese, nickel, and antimony ores in the United States have hitherto been considered of too low grade to justify development. The Bureau for some years has been attempting to devise low-cost methods of extracting a product of commercial grade from these minerals in order to build up potential sources of supply and eventually to preclude the necessity of importation. The results of this work with respect to chromium and manganese have already been mentioned. Similar work is being done on magnesium needed in airplane construction. A study of the treatment of pegmatite tin ores is now under way and, if successful, may make it possible for this country to produce in emergency at least a part of its tin supplies now obtained from foreign countries. A study of the potash resources of the Southwest has already resulted in the establishment of a potash industry in that region.

In the field of nonmetallic minerals the Bureau studies the improvement and utilization of such minerals as lime, clay, feldspar, fluorspar, talc, and mica. The Nation has important deposits of these minerals, and the Bureau's work has shown that it is feasible to improve them by suitable treatment so that they can replace imported materials. For example, the studies of native deposits of potash, already mentioned, have freed this country from dependence on foreign sources for this important mineral.

The recent depression taught a salutary although bitter lesson, namely that, even in mining, technology in itself was not enough. The United States reached industrial maturity some years ago and became overprosperous. For 50 years before the hard times huge supplies of mineral raw materials were called for as the railroad network was completed and all forms of manufacture

expanded; also the country went into a delirium of mining during the World War. Then came the hard times, when disappearing markets, unemployment, disheartening surplus stocks of metals, and low-cost foreign raw materials threatened the very existence of mining in many districts.

Producers discovered that there was no insatiable demand for their wares. Prices naturally crumbled and slithered to unprofitable levels. Mining men learned that it is necessary for the producer systematically to follow mineral materials through all intermediate steps to their ultimate uses and not to dismiss the raw material from thought as it cleared the mining plant; that it is necessary to study the adjustment of producing capacity to influences that cause local and world-wide trends in consumption; that technologists, capitalists, executives, and labor organizations need to be saturated with the economics of the business; and that continued individualistic attitudes and company isolation are out of step with sound progress. As already stated, the country had passed the pioneer stage when an unplanned production could be consumed to support an equally rapid commercial growth.

Because of the seriousness of the national economic situation the work of the Bureau of Mines dealing with mineral economic investigations was reorganized and enlarged to give mining people a complete economic picture, including both the production and the utilization of mineral resources. In addition to the collection of the customary statistical data the economics work of the Bureau was expanded to include studies of basic trends in production, consumption, and prices; recent developments in employment and safety; government activities affecting the mineral industries; income of mining companies; foreign trade in minerals; and economic aspects of international mineral policies, all of which affect not only the economic, political, and social phases of mining but have a definite relation to the efficient use of the Nation's minerals and conservation of its natural resources.

Thus, the importance and value of the country's mineral resources, their value in use, and the need for both technology and economics in the production and utilization of these resources are seen. Especially to be emphasized is utilization - utilization efficiently and without waste; which is true conservation.